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ORIGINAL ARTICLE

CONSIDERATION OF THE CONTENTS OF DISASTER-NURSING EDUCATION IN BASIC NURSING EDUCATION: KNOWLEDGE AND PRACTICAL ABILITIES REQUIRED FOR EFFECTIVE RADIATION-DISASTER NURSING

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Abstract The aim of this study was to clarify the knowledge and practical abilities required by professional nurses, nursing students, and nursing teachers, to provide appropriate radiological nursing care in a radiation-disaster. To examine this, a semi-structured interview survey was conducted with 14 experts involved in radiation-disaster nursing or radiation-related-medical care. The survey contained three questions concerning radiation-disaster nursing: (1) What knowledge and practical abilities are required by nursing professionals? (2) What basic knowledge is required by nursing students? (3) What knowledge and experience are required by nursing teachers? After transcribing comments using KH Coder (3.0.0.0) software, we performed quantitative-text mining analysis. Hierarchical cluster analysis showed that, for question one, the experts prioritized knowledge of "health effects of radiation and addressing patients' anxiety," "the role of nurses," and "radiological nursing." For question two, "radiological nursing," "radiation protection basics," "radiation emergency medicine," "role of nursing," etc., were prioritized. Finally, for question three "knowledge of nuclear power plant accidents," "disaster prevention drills, dose measurements, etc., performed at hospitals," "radiation nursing and correspondence with inhabitants," "radiation fundamentals," etc., were prioritized. The findings show that future disaster-nursing education should incorporate radiation-nursing education.

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Key words: disaster; education; nursing; radiation; care.

Introduction

Global nursing personnel with appropriate knowledge and skills are required in the event that a sudden disaster occurs, such as an outbreak of infectious disease, human conflicts, and natural disasters.

The World Health Organization explained that effective emergency and disaster reduction includes prevention, mitigation, preparedness, early response, and rehabilitation. Further, it emphasized that precautionary measures and plans are of primary importance[1]. In addition, the International Council of Nurses (ICN) has formulated the ICN Framework of Disaster Nursing Competencies, showing that nurses, as primary healthcare providers, are indispensable in disaster situations[2]. Consequently, research on disaster-nursing education has increased in recent years[3-12].

Since the Great Hanshin-Awaji Earthquake of 1995, disaster-nursing education has been strongly emphasized in Japan and interest in research and education concerning disaster nursing has intensified. Further, the globally unprecedented radiation disaster that followed the Great East Japan Earthquake of 2011 highlighted the roles required of nurses in such events. Studies of education concerning radiation disasters and radiation nursing have shown

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that there is a lack of knowledge among nursing students, nursing teachers, and other nursing professionals, including public health nurses, regarding radiation; thus, the need to develop a means for providing basic radiation knowledge in nursing education is evident[13-19].

Aim

This study aimed to clarify the knowledge and practical abilities required of nursing professionals, nursing students, and nursing teachers, to ensure appropriate provision of nursing care in a radiation-disaster, and to reference material that can be used in basic nursing education in Japan. This may facilitate the academic systematization of disaster-nursing science in basic nursing education and may also lead to an improvement in nursing specialty care.

Methods

1. Participants

The participants were 14 experts on radiation disaster nursing or medical care in Japan.

2. Methods

We conducted interview surveys between November 8, 2016, and March 1, 2017. Specifically, these semi-structured interviews concerned the knowledge and practical abilities required by nursing professionals, the basic knowledge required by students, and the knowledge and experience required by teachers to ensure the adequate provision of radiation-disaster treatment. In the interviews, we asked the following questions, clarifying that responses should be given regarding radiation-disaster nursing:

(1) What are the knowledge and practical abilities required by nursing professionals?

(2) What is the basic knowledge required by nursing students?

(3) What is the knowledge and experience required by nursing teachers?

The interviews in Japanese lasted 30–60 minutes. We recorded the contents of the interviews using a digital recorder and then transcribed them.

3. Analysis method

We performed quantitative text-mining analysis using KH Coder (ver.3.0.0.0). By omitting the manual work required to summarize and present data, KH Coder eliminates a researcher's unconscious bias. This improves the objectivity and reliability of the analysis.[20]

4-1. Morphological analysis

Morphological analysis concerns decomposing text data (the transcribed records) into each part of speech. For each of the three categories of text data (i.e., the responses to questions 1-3), we applied frequency analysis to determine the appearance frequency of each term. Furthermore, we extracted feature words that were deemed to be characteristic of the respective responses to the three questions.

4-2. Relationship analysis of extracted terms: Hierarchical cluster analysis and correspondence analysis

We analyzed the relevance between extracted words and searched for links between text parts (sentences/items) and word features. For each of the three categories of text data for questions 1-3, the appearance frequency was set so that the 40 most-frequently used words were targeted; this meant that words with similar meanings were grouped. Cluster analysis was also conducted; each cluster was given a name that was characteristic of its contents. To conduct the analysis qualitatively and inductively, we read the interview transcripts repeatedly and sought to gain an overall understanding of the responses.

4-3. Relationship of extracted terms: Correspondence analysis

Then we compiled the three categories of text

Table 1 Demographic details

(n = 14)

		Nurse	Nurse & Public Health Nurse	Medical Doctor & Dentist	Medical Radiation Technologist	Total
sex	Male	1	1	1	1	4
	Female	8	1	1	0	10
Disaster support activities	experienced	6	2	1	1	10
	no experience	3	0	1	0	4
Age	30s	1	1	0	0	2
	40s	3	1	0	0	4
	50s	4	0	2	1	7
	60s	1	0	0	0	1
Average age		50.0 ± 9.46	41.5 ± 10.61	57.0 ± 1.41	56.0 ± 0	50.21 ± 9.23
Average medical career		13.22 ± 5.81	5.00 ± 7.07	27.5 ± 4.95	35 ± 0	15.64 ± 9.92

data and conducted a correspondence analysis to obtain an overview of the word features and word-appearance patterns for each category. We also adjusted the minimum and maximum number of occurrences so that the 60 most-common words were presented in order, which simplified the appearance of the analysis result.

5. Ethical considerations

This study was conducted with the approval of the Research Council for Ethics of the Japanese Red Cross Akita Nursing College/Japanese Red Cross Akita Junior College (registration number: 28-114). The study participants were informed of the study purpose and methods; that they had the right to refuse participation, to withdraw, and to withdraw their data after the interview; that the researchers would protect the privacy of their data; and that the data would not be used for purposes other than the present research. The participants then provided written consent.

Results

The participants' demographic details are shown in Table 1.

1. Morphological analysis of the interview data

Text data for question one contained 344 sentences, with 11,878 words extracted in total. Of these, 4,054 words were analyzed, and each word occurred an average of 4.28 times. Text data for question two contained 530 sentences, with 15,068 words extracted in total. Of these, 4,521 words were analyzed, and the average number of occurrences was 5.00. Question three had 275 sentences and 9,024 words. Of these, 3,519 words were analyzed and the average number of occurrences was 3.89. Among the detected compound words, nine words that were detected more than 20 times were designated as words to be forcibly extracted: "nurses" (83 times), "radiation disaster" (35), "peoples" (31), "dosimetry" (31), "decontamination" (29), "disaster nursing" (26), "medical radiation technologists" (22), "risk communication" (20), and "public health nurse" (20). Additional words that occurred, "frame," "time," "unit," and "year," did not reflect the purpose of this study, so we excluded them. The 50 most-frequently used words in the text data for questions 1-3 are shown in Table 2.

To determine the words that most-characterized each item, the Jaccard coefficient similarity measure was used to list the 10 best-fitting items in descending order (taking values from 0 to 1, with values closer to 1 representing a stronger relationship) (Table 3). Question words that were deemed to be characteristic of the text data included "exposure," "medical," "dose," "anxiety," and

Table 2 The 50 most-frequently used words

<Question one> Knowledge and practical abilities required by nursing professionals		<Question two> Basic knowledge required by nursing students		<Question three> Knowledge and experience required by nursing teachers	
Extraction word	Number of occurrences	Extraction word	Number of occurrences	Extraction word	Number of occurrences
radiation	115	radiation	232	think	80
exposure	110	think	205	radiation	80
think	87	nursing	92	knowledge	50
medical	84	disaster	70	medical	42
disaster	55	knowledge	59	education	38
nuclear power	45	foundation	55	nurses	35
nurses	42	education	53	nursing	32
necessary	40	medical	47	exposure	32
anxiety	39	nurses	47	necessary	31
knowledge	37	students	46	nuclear power	28
patients	36	teach	44	disaster	28
person	36	necessary	44	experience	26
pollution	33	person	40	see	25
correspondence	32	exposure	39	say	24
hospital	32	say	34	story	24
accident	31	know	34	fundamentals	21
say	30	treatment	33	receive	21
inhabitants	29	oneself	31	specialty	21
nursing	27	receive	29	training	20
effect	26	see	28	teach	19
oneself	25	story	28	oneself	19
dose	25	enter	27	inhabitants	18
dosimetry	22	subject	26	have	17
story	22	basics	26	hear	17
appear	20	disaster nursing	26	dosimetry	16
know	19	lecture	25	medical radiation technologists	16
understand	19	patients	24	teachers	15
decontamination	18	effect	23	hospital	15
enter	18	have	23	radiation disaster	15
generation	18	contents	23	drill	14
refuge	18	correspondence	22	patients	13
generalist	17	practice	21	treatment	13
level	17	judgment	21	generation	13
emergency	17	consider	20	appear	12
do	17	public health nurse	20	come	12
treatment	17	protection	20	students	11
people	17	dose	18	enter	11
measurement	17	exercise	17	accident	10
see	17	hospital	17	measurement	10
manual	16	specialty	14	consider	9
medical doctors	16	measurement	14	make	9
examination	15	understand	14	public health nurse	9
protection	15	pollution	13	protection	9
come	15	lesson	13	first aid	8
specialist	14	appear	13	emergency	8
all right	14	afraid	13	do	8
consider	13	risk communication	12	administration	8
go	13	nuclear power	12	assumption	8
specialty	13	explanation	12	wear	8
hear	12	tell	12	put	8

The 50 most-frequently used words in the text for questions 1-3.

"hospital," which suggested that the priorities for nursing professionals are "knowledge regarding radiation medical care at hospitals" and "the ability to respond to patients' anxiety concerning radiation effects." For question two, words deemed to be characteristic of the text data included "thinking," "radiation," "nursing," "student," "disaster," and "fundamentals," which suggested that basic knowledge important to nursing students includes radiation fundamentals and disaster nursing. For question three, "knowledge," "education," "medical care," and "nuclear power," among others, were deemed characteristic, which suggested that nursing teachers require knowledge of actual nuclear power plant accidents and disaster medical care.

Table 3 Representative feature words
(Numerical values are similarity measure of Jaccard)

<Question one> Knowledge and practical abilities required by nursing professionals		<Question two> Basic knowledge required by nursing students		<Question three> Knowledge and experience required by nursing teachers	
exposure	.172	think	.255	knowledge	.104
medical	.142	radiation	.220	education	.090
necessary	.092	nursing	.124	medical	.088
nurses	.087	fundamentals	.092	nurses	.088
disaster	.084	students	.082	necessary	.076
anxiety	.081	teach	.073	nuclear power	.074
patients	.075	education	.069	understand	.073
inhabitants	.074	know	.051	say	.072
say	.068	treatment	.047	disaster	.069
hospital	.067	lecture	.047	receive	.068

To determine the words that most-characterized each item, the Jaccard coefficient similarity measure was used to list the 10 best-fitting items in the descending order (taking values from 0 to 1, with values closer to 1 representing a stronger relationship).

2. Relationship analysis of extracted words: Hierarchical cluster analysis

For each of the three categories of text data for questions 1-3, we used hierarchical cluster analysis to search for combinations of similar words and appearance patterns (Ward method, Jaccard distance). To facilitate the conceptualization of the cluster names, we analyzed only "noun," "verbal noun" (a noun derived from a verb), "adjective verb," and "verb." Then, we applied KWIC (key word in concept) concordance to the results of the cluster analysis and carefully named them based on the content of the transcribed records.

2-1. Question one: Knowledge and practical abilities required by nursing professionals

For question one responses we performed a hierarchical cluster analysis using the top 44 words with an occurrence count of 15 times or more (Figure 1). Through connecting the phrases, seven clusters were constructed.

The first cluster (C1) comprised "accident," "nuclear power," and "generation," and it was named "radiation disasters caused by nuclear power plant accidents." The second cluster (C2) comprised "exposure," "medical," and "emergency," and we named it "radiation emergency medicine." The third cluster (C3) comprised "radiation," "disaster," "correspondence," etc., and we named it "health effects of radiation and addressing patients' anxiety." The fourth cluster (C4) comprised "thinking," "necessary," "knowledge," etc., and we named it "role of nursing professionals." The fifth cluster (C5) comprised "nursing," "say," "story," etc., and we named it "radiological nursing (nursing examinations and treatment)." The sixth cluster (C6) comprised "inhabitants," and "refuge," and we named it "correspondence with inhabitants." The seventh cluster (C7) comprised "nurse," "person," "hospital," etc., and we named it "radiation disaster response manuals in hospitals."

2-2. Question two: Basic knowledge required by nursing students

Similarly, for question two, we performed hierarchical cluster analysis using the top 38 words with an occurrence count of 15 times or more (Figure 2). Through connecting phrases, six clusters were constructed.

The first cluster (C1) comprised "treatment," "receive," and "patient," and we named it "radiological nursing (nursing examinations and treatment)." The second cluster (C2) comprised "radiation," "think," "nursing," etc., and we named it "correspondence during radiation disasters, and radiation fundamentals." The third cluster (C3) comprised "knowledge," "student," "necessary," etc., and we named it "radiation protection basics." The fourth cluster (C4) comprised "medical," and "exposure," and we named it "radiation

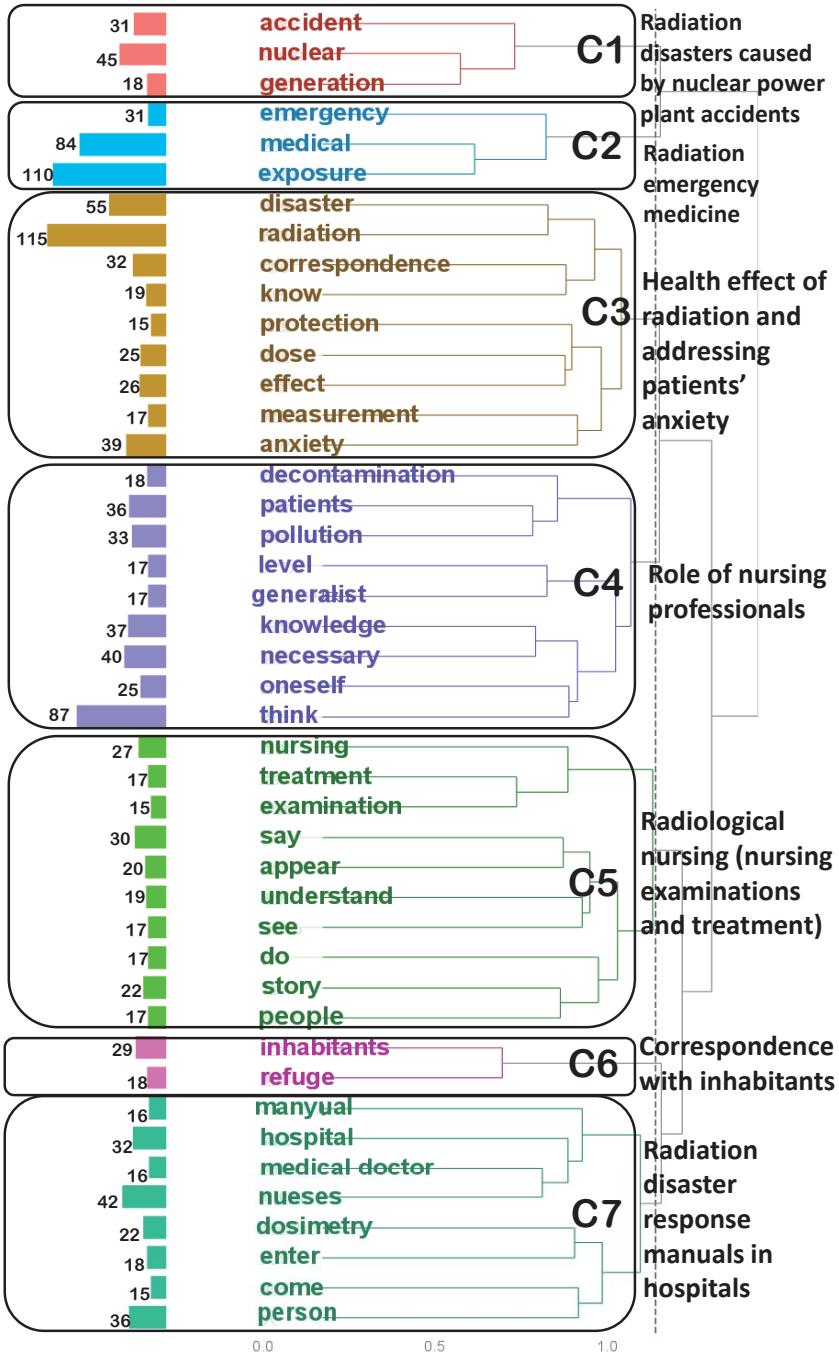

Figure 1 Question one: Knowledge and practical abilities required by nursing profession
The top 44 words with an occurrence count of 15 or more.
Method: Ward. Distance: Jaccard. Number of occurrences. "C" is cluster number and cluster name.
In dendrograms, words with similar appearance patterns are connected to the left more vertically.

emergency medicine."

The fifth cluster (C5) comprised "nurse," "oneself," "have," etc., and we named it "role of nursing professionals." The sixth cluster (C6) comprised "say," "know," "see," etc., and we named it "health effects of radiation."

2-3. Question three: Knowledge and experience required by nursing teachers

For question three responses, we performed hierarchical cluster analysis using the top 33

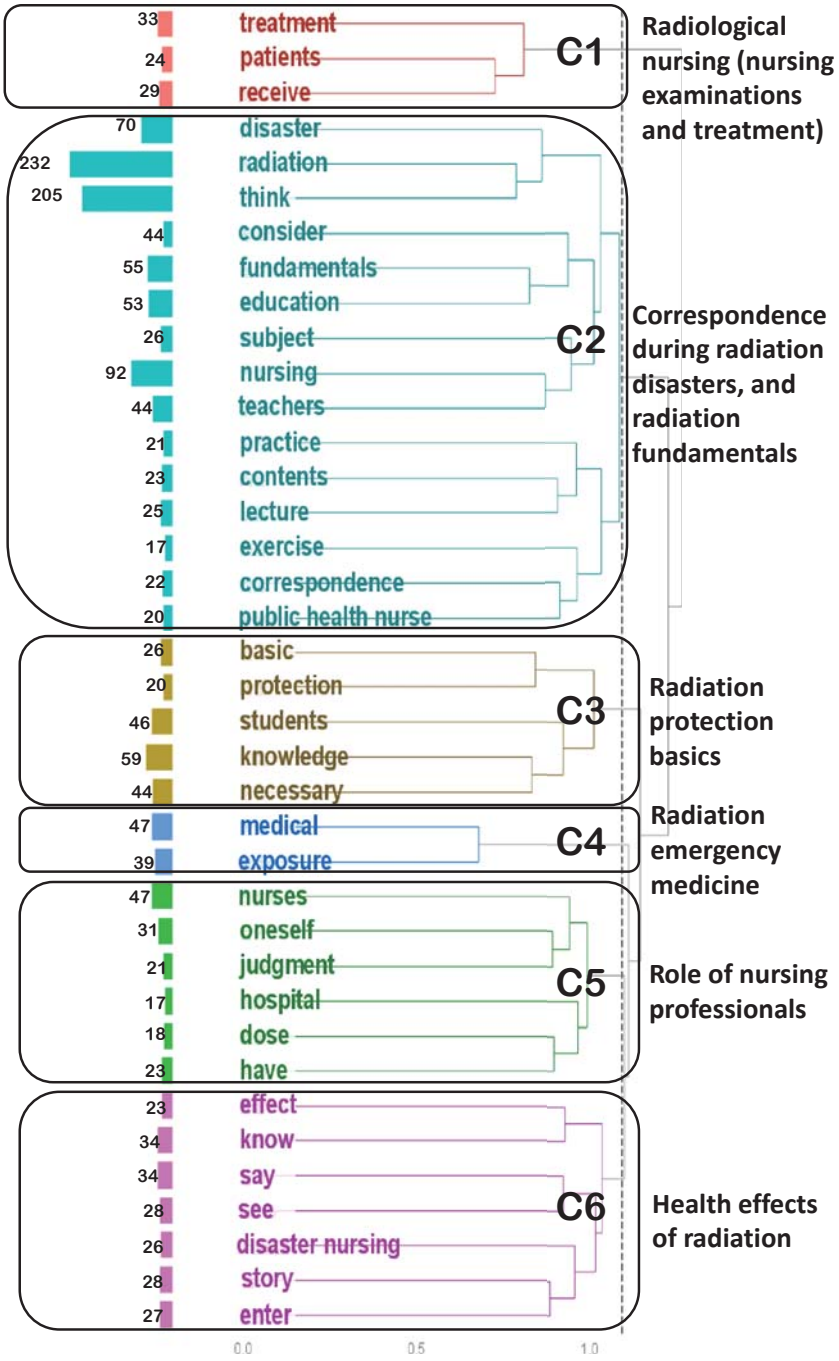

Figure 2 Question two: Basic knowledge required by nursing students
The top 38 words with an occurrence count of 15 or more. Method: Ward. Distance: Jaccard. Number of occurrences. "C" is cluster number and cluster name.
In dendrograms, words with similar appearance patterns are connected to the left more vertically.

words with an occurrence count of 13 times or more (Figure 3). Through connecting phrases, six clusters were constructed.

The first cluster (C1) comprised "nuclear power," and "generation," and we named it "outline of nuclear power plant accidents." The second cluster (C2) comprised "see," "say," "dosimetry," etc., and we named it "disaster prevention drills, dosimetry, etc., at hospitals." The third cluster (C3) comprised "story," "inhabitants,"

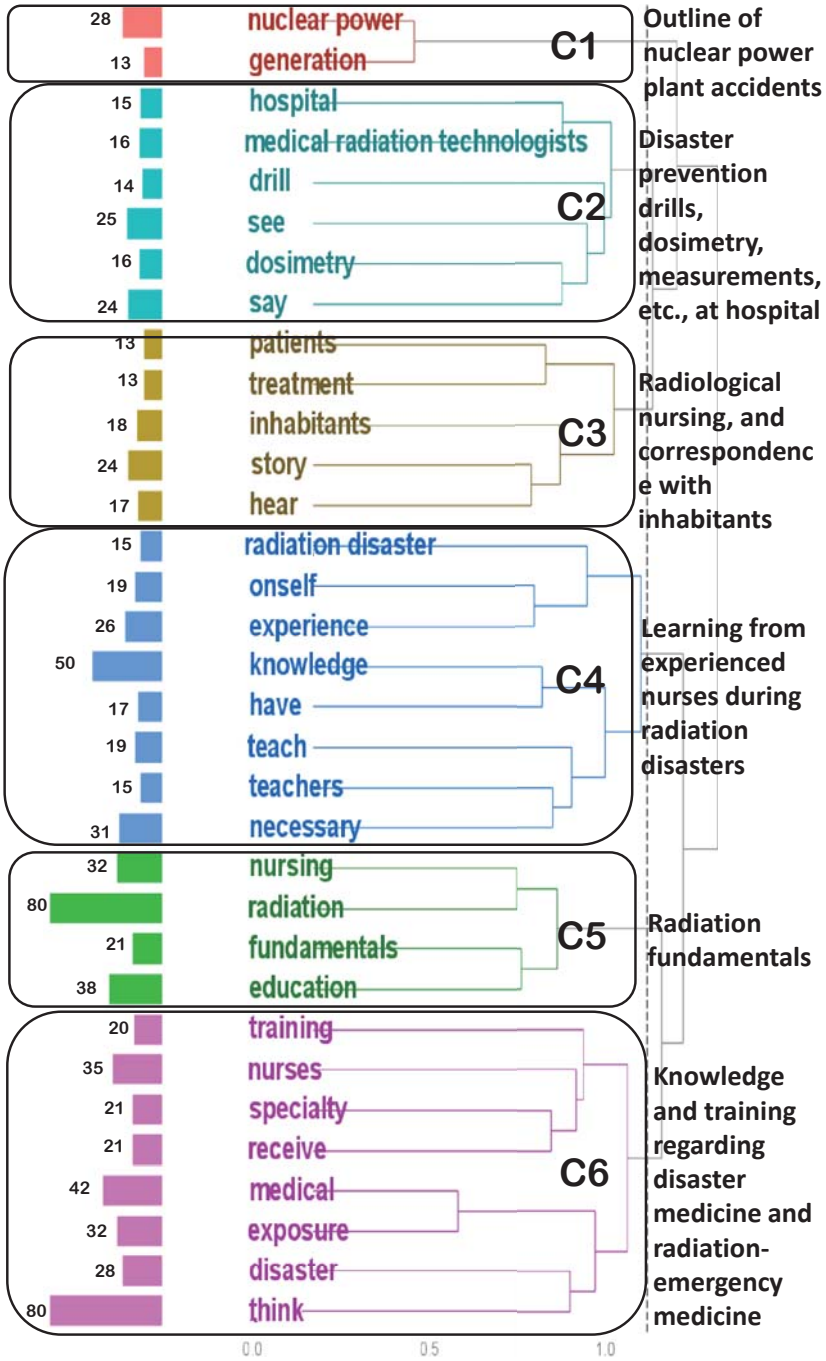

Figure 3 Question three: Knowledge and experience required by nursing teachers
The top 33 words with an occurrence count of 13 or more.
Method: Ward method. Distance: Jaccard. Number of occurrences. "C" is cluster number and cluster name.
In dendrograms, words with similar appearance patterns are connected to the left more vertically.

"hear," etc., and we named it "radiological nursing, and correspondence with inhabitants." The fourth cluster (C4) comprised "knowledge," "necessary," "experience," etc., and we named it "learning from experienced nurses during radiation disasters." The fifth cluster (C5) comprised "radiation," "education," "nursing," etc., and we named it "radiation fundamentals." The sixth cluster (C6) comprised "think," "medical," "nurse," etc., and we named it "knowledge

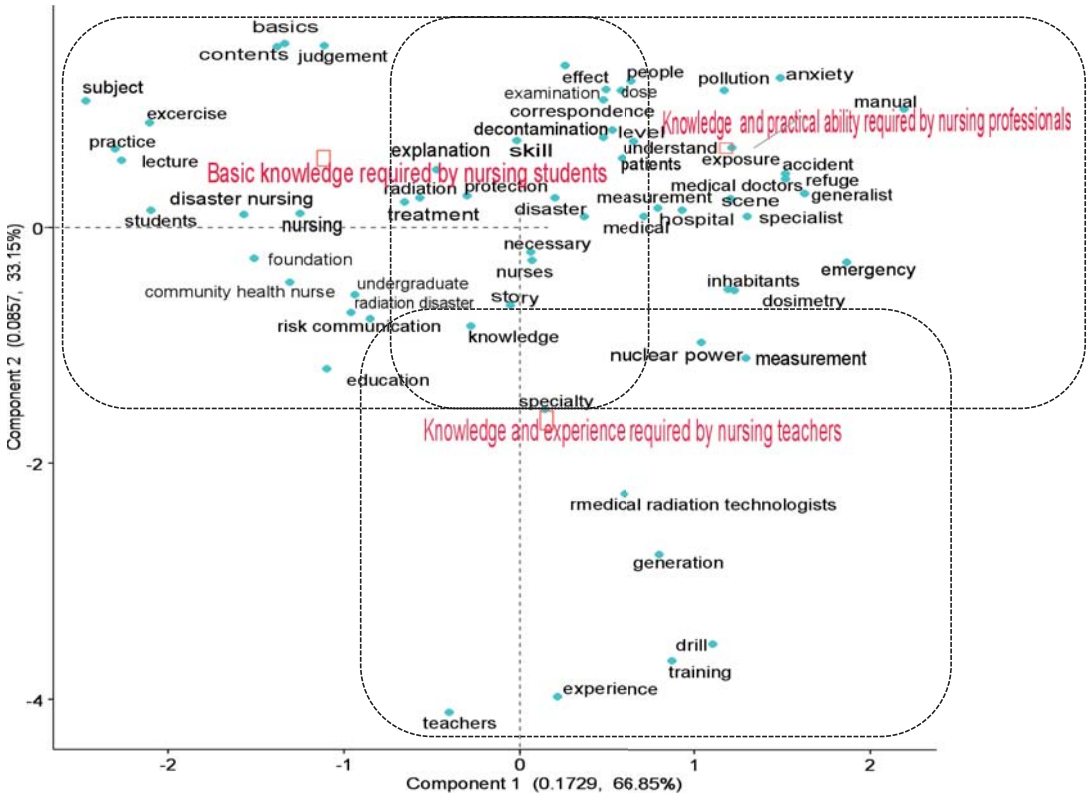

Figure 4 Correspondence analysis
The contribution ratio is 67.8% for the first component and 31.2% for the second component with a cumulative contribution ratio of 100%. Minimum number of occurrences: 20; top 60 occurrences; word count: 63.
In the correspondence analysis, words having no feature in appearance pattern are plotted in the vicinity of the origin (0, 0). From the point of origin, it can be interpreted that the word plotted in the direction of each of the three items, the word that is further away from the origin, is the word that characterizes each of the three items.

and training regarding disaster medicine and radiation-emergency medicine."

3. Relationship analysis of extracted words: Correspondence analysis

To examine appearance patterns for each category, we conducted a correspondence analysis of the extracted words. For this analysis, the minimum number of appearances was set to 20, the minimum number of documents was set to one, the top 60 words were used, and the external variables were question 1-3; the results are shown in Figure 4. The contribution ratio of component 1 was 67.8%, the contribution ratio of component 2 was 31.2%, and the cumulative contribution ratio of the two components was 100%, which indicated that we obtained reliable results. In the correspondence analysis, words with similar appearance patterns were closely related. The results were interpreted based on distance and direction from the origin (0, 0), with items located near the origin being most similar. The farther from the origin a word is, the more likely it is to represent a characteristic word for items located nearby. Consequently, "experience," "training," and "teacher" were determined to be characteristic words for question three because they were close to question three and located far from the origin. Similarly, "manual" is close to question one, and because it is located far from the origin it was considered characteristic of question one.

Discussion

In this study, we conducted quantitative text analysis using text mining, with the aim

of clarifying the knowledge and practical abilities required by nursing professionals, nursing students, and nursing teachers regarding radiation-disaster nursing.

1. Question one: Knowledge and practical abilities required by nursing professionals

In the responses to question one, words such as "radiation," "exposure," "think," "medical," and "disaster" appeared frequently, indicating that nursing professionals must obtain basic knowledge on radiation-disaster medical treatment and radiation-exposure medicine. Further, among the seven items extracted through cluster analysis, "radiation disasters caused by nuclear power plant accidents" showed the need for nursing professionals to obtain knowledge regarding the mechanisms that cause radiation accidents in nuclear power plants. Moreover, the appearance of "radiation emergency medicine" showed the need for knowledge regarding the appropriate medical practice to apply during a radiation disaster. In the correspondence analysis, "manual" was found to be a distinctive word, indicating a need to create a "radiation disaster response manual for hospitals" as a measure to address future radiation disasters. In addition, when considering the eight items on the current nursing student curriculum that represent the minimum radiation-nursing knowledge and skills required by nursing staff,[19] all were mentioned by our respondents. This suggests that "radiation disasters caused by nuclear power plant accidents" and "radiation disaster response manual for hospitals" are characteristic of radiation disaster nursing.

2. Question two: Basic knowledge required by nursing students

In the responses to question two, words such as "radiation," "think," "nursing," and "disaster" occurred frequently, and through this we inferred that it is necessary for nursing students to acquire knowledge regarding radiation disasters and disaster nursing. Among the six items extracted through cluster analysis, "correspondence in radiation disasters, and radiation fundamentals" contained the largest number of words and indicated a need for basic knowledge of radiation, including radiation disasters. Meanwhile, "radiation protection basics" was extracted as a characteristic of required knowledge for nursing students.

Radiation protection is an essential element of radiation nursing[21] and has been proposed as an academic foundation of radiation nursing.[22] For nursing students, "radiation protection basics" was extracted because radiation protection is required knowledge. Furthermore, at nursing colleges in Japan, the "three principles of radiation protection," "radiation exposure and the effect on the human body," "nursing in radiation therapy," etc.,[23] are emphasized in radiation-nursing education. This study obtained similar results.

In a study on radiation risk consciousness, it was shown that nursing students most wish to know how to "respond in cases of radiation accidents" and "method of using radiation in medical science."[24] This is similar to the results of this study, indicating that it was possible to extract contents corresponding to the needs of students.

3. Question three: Knowledge and experience required by nursing teachers

In the responses to question three, words such as "think," "radiation," "knowledge," and "medical" occurred frequently, and through this we inferred that nursing teachers need to acquire knowledge about radiation medicine and understand the need for basic knowledge regarding radiation. Among the six items extracted through cluster analysis, "knowledge and training regarding disaster medicine and radiation-emergency medicine" had the largest number of words, indicating the need for knowledge regarding disaster medicine and radiation-emergency medicine. Similarly, in the

results of the correspondence analysis, "experience," "training," "drill," and "teacher" were shown to be characteristic words for nursing teachers. Radiation disasters do not occur frequently, so there are few disaster-support experts available to nursing teachers. Therefore, it is necessary to consult with experienced staff and to examine previous research to improve knowledge regarding the role of nurses in radiation disasters and to apply this in education. This is a manifestation of "learning from experienced nurses during radiation disasters."

The ability to provide disaster-related medical relief and to have knowledge about the experiences of disaster volunteers have been reported as necessities for faculty in charge of teaching disaster-nursing.[25] Further, it has been reported that radiation safety training and, conducting radiation safety courses before commencing employment, along with regular training thereafter, are necessary for nursing students. Additionally, it has been inferred that nursing teachers also need continued training.[26]

"Radiological nursing" and "radiation emergency medicine" were extracted from responses for all three questions, indicating that these represent the most necessary elements of basic knowledge. Additionally, the findings replicate some of the current contents of radiation nursing education, suggesting that further refinement of radiation-disaster nursing education content is required.

Limits of research and future issues

Survey participants were mostly medical persons involved in support operations immediately after radiation disasters. For this reason, few of the radiation catastrophe factors came from a long-term perspective. Also, it was difficult to distinguish the role of general nurses from that of public health nurses, which introduced some ambiguity. Future analyses should classify contents according to the disaster cycle and the role sharing of general nurses and public health nurses. Additionally, although the survey participants were experts in radiation disaster nursing and medical care in Japan, as the number of people was still small, it can be said that the limit of the research is that the sample size of 14 people was small. The ICN framework of disaster nursing competencies, developed in 2014,[2] has been disseminated around the world and reviews of disaster nursing education are underway based on this framework. However, the ICN framework of disaster nursing competencies does not include radiation-disaster nursing. Therefore, we hope that the findings of this study will encourage further examination of disaster-nursing education.

Disclosure

The authors have no conflicts of interest directly related to the content of this article.

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